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**ABUNDANCE AND DISTRIBUTION OF SAW-WHET OWLS  
(*AEGOLIUS ACADICUS*) ON SANTA CRUZ ISLAND**

**A THESIS**

**Presented to the Department of Biological Sciences  
California State University, Long Beach**

**In Partial Fulfillment  
of the Requirements for the  
Master of Science in Biology**

**By Jeff W. Johnson  
B.A., 1992, California State University, Long Beach  
December 1999**

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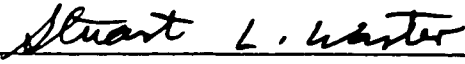
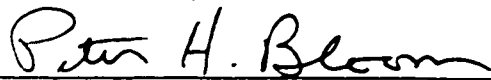
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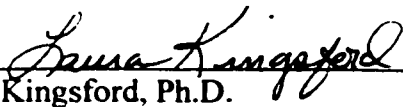
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## ABSTRACT

### ABUNDANCE AND DISTRIBUTION OF SAW-WHET OWLS (*AEGOLIUS ACADICUS*) ON SANTA CRUZ ISLAND

By

Jeff W. Johnson

December 1999

The habitat affinities and distribution of the Northern Saw-whet Owl (*Aegolius acadicus*) near the southern end of its range on Santa Cruz Island, California have not been previously studied. I conducted auditory surveys for Saw-whet Owls within several habitat types. Saw-whet Owls occurred in each of three habitat types: pine forests (*Pinus muricata*), oak woodlands (*Quercus agrifolia*), and non-native eucalyptus groves (*Eucalyptus globulus*) with an estimated total population of 106-148 individuals. Territory holding males were detected calling earlier in the season than reported in other studies, suggesting that this island population is non-migratory. Breeding was documented by means of the owls' use of nest boxes. The population seems stable and not in need of management efforts.

## **ACKNOWLEDGEMENTS**

**I wish to acknowledge the dedication and guidance that Dr. Charlie Collins gives to each of his many students, and thank him for the personal friendship through many great life experiences. I thank my other committee members Dr. Stuart Warter and Pete Bloom for their guidance and Lyndal Laughrin for travel coordination and use of the U.C. facility on Santa Cruz Island. Financial Support for this project was received from the Will J. Reid Foundation. Most of all I would like to thank my wife Michelle for her support and understanding and my son Rennik for giving me the motivation to finish.**

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## CHAPTER 1

### INTRODUCTION

The genus *Aegolius* (Kaup) consists of four species of small secretive owls, of which two have wide distributions in north America: the Northern Saw-whet Owl, *Aegolius acadicus* (Gmelin) and the Boreal Owl, *Aegolius funereus* (Linnaeus) (Peters 1940, Burton 1973, American Ornithologist's Union 1983). Saw-whet and Boreal Owls are widely associated with northern hemisphere forests (Johnsgard 1988), while the Unspotted Saw-whet Owl *Aegolius ridgwayi* (Alfaro) and Buff-fronted Owl *Aegolius harrisii* (Cassin) (Peters 1940) are found in high elevation forests of Central and South America (Burton 1973; American Ornithologist's Union 1983; Johnsgard 1988).

The Boreal Owl is holarctic in distribution, and, as its name implies, is found typically in northern boreal forests. The Saw-whet owl is common in the higher elevation coniferous forests of the United States and Canada but also inhabits a variety of other forest types throughout its range (Burton 1973; Godfrey 1986; Johnsgard 1988; Cannings 1993). In parts of its range the Saw-whet Owl is migratory; the bulk of northeastern populations migrate to east-central United States (Mueller and Berger 1967; Holroyd and Woods 1975; Weir, Cooke, Edwards and Stewart 1980; Duffy and

Kerlinger 1992) sometimes crossing large bodies of water such as the great lakes (Taverner and Swales 1911).

The Saw-whet owl is one of the smaller north American owls with a mean mass of 74.9 and 90.8 grams in males and females, respectively (Dunning 1993). The adults have upper-parts streaked brown and flecked with white on their back and forehead (Cannings 1993). Lacking distinguishable ear tufts or “horns,” this is an easily identifiable owl. However, due to its inhabiting dense woodlands, its presence is more commonly detected by the distinctive territorial call: a repetitive single note whistle, thought to sound similar to the sharpening of a saw blade.

The Saw-whet Owl’s range extends south to southern California in the western United States (Garrett and Dunn 1981; American Ornithologist’s Union 1983). However, most of the information on Saw-whet Owls in this area consists of anecdotal accounts of their occurrence at various localities (Garrett and Dunn 1981; Unitt 1984; Hamilton and Willick 1996). It has only recently been confirmed as a resident breeder in the San Gabriel Mountains (K. Garrett pers. comm).

Saw-whet Owls are known to occur on two of the California Channel Islands. These owls were documented to be present on Santa Cruz Island as early as 1931 (Hoffman 1931) and have been frequently reported since then (C. Collins and L. Laughrin pers. comm). Recent studies have clarified their status on Santa Catalina Island as well (Garcelon and Romsos 1994).

In light of the paucity of information on this secretive species in the southern part of its range, the purpose of this study was to 1) determine the distribution and habitat associations of the Saw-whet Owl on Santa Cruz Island and 2) estimate its current population size on the island. Additional goals of this study were to learn more about the breeding biology and seasonality of breeding of Saw-whet Owls on Santa Cruz Island.

## **CHAPTER 2**

### **STUDY AREA**

**Santa Cruz Island is approximately 37 km long, 11 km at its widest point and located 30 km off the coast of Santa Barbara, California. It is the largest of the eight Channel Islands and the most topographically diverse with marine terraces, deep ravines and parallel mountain ranges that create a central valley (Minnich 1980).**

**Characterized by warm dry summers and mild winters, the island's Mediterranean climate is comparable to that of coastal regions of mainland southern California. The majority of the island is heavily influenced by a coastal marine layer and is generally a few degrees cooler than mainland areas due to exposure to the cool outer channel waters. However, the interior central valley has high temperatures similar to those 20 miles inland on the mainland during the summer yet can reach sub-freezing temperatures during late fall, winter and early spring. The entire island is subject to periodic windy conditions throughout the year, especially along ridge tops (Minnich 1980).**

**Santa Cruz Island has had a checkered history of human habitation of the Central Valley for purposes of cattle ranching, sheep grazing and cultivating vineyards (Brumbaugh 1980; Hobbs 1980; Junak 1995). Although the native plant communities have been substantially modified since the introduction of sheep more than a century**

ago (Brumbaugh 1980), much of the native vegetation remains today (Barbour and Major 1988). After the removal of sheep from most of the island during the 1970s, revegetation has been rapid (Minnich 1980) and habitats are beginning to recover from overgrazing (Junak 1995).

With exposure to cold outer channel waters, steeply sloping mountain ranges reaching nearly 700 meters in height, and a Central Valley, Santa Cruz Island is the most climatically diverse of the Channel Islands. The vegetation on the island has been categorized into 6 habitat types: 1) grasslands dominated by European annuals, 2) coastal sage scrub dominated by *Artemisia californica*, *Salvia apiana*, *Baccharis pilularis*, with patches of prickly pear (*Opuntia*), 3) chaparral dominated by *Artostaphylos*, *Ceanothus*, and *Rhus integrifolia* with *Quercus dumosa* on north-facing slopes in the central valley, 4) oak woodland dominated by *Quercus agrifolia*, 5) riparian woodland consisting of *Salix* spp., *Populus fremontii* and *Baccharis glutinosa*, and 6) Bishop pine (*Pinus muricata*) forests (Minnich 1980). For the purpose of this study, I added another habitat type, eucalyptus woodland, consisting of groves of introduced Blue-gum eucalyptus (*Eucalyptus globulus*).

## CHAPTER 3

### METHODS

I used a modified point count survey procedure to identify the presence of Saw-whet Owls. Driving accessible roads, I stopped at regular intervals approximately 0.5 miles apart within selected representative areas of appropriate habitat types. At each stop the following procedures were followed: 5 min of listening followed by 5 minutes of whistled imitations of the single note call followed by an additional 5 minutes listening for a response. These surveys were conducted at various times from dusk to dawn with the majority between one hour after dusk and 02:00 a.m.; Palmer (1987) notes that Saw-whet Owls generally start calling within one hour after sunset and calling lasts until well after midnight. Surveys were conducted only when weather conditions allowed reasonable assurance of detection of vocalizing owls within 0.3 miles; they were not conducted during extreme conditions of rain, wind or dense fog. Most surveys were conducted during conditions that allowed for detection within 0.5 mile and possibly up to 1.0 mile under ideal conditions. Areas of extensive marine terrace grasslands and *Opuntia* were excluded from these surveys as such areas are unsuitable habitat for woodland inhabiting Saw-whet owls (Cannings 1987; Swengle and Swengle 1987). On Santa Cruz Island, Saw-whet Owls have been previously recorded from oak woodland, pine forest, riparian areas and eucalyptus

groves (C. Collins and L. Laughrin pers. comm) and therefore this study focused on these areas. Similarly, Saw-whet Owls are not known to inhabit coastal sage scrub or chaparral and these areas were not focused upon in the point count surveys. However, due to the patchy distribution of plant communities on Santa Cruz Island, substantial areas of chaparral and coastal sage scrub were encompassed by the surveys.

The locations of the calling owls were determined by approximating distance and bearing from the point of detection. If either of these were not easily determined, additional measurements were taken from another position to ensure accurate location through triangulation. All positions of calling owls were then located and marked on a USGS 7.5 minute series topographical map as described in Swengle and Swengle (1987) then digitized using the program AutoCad. Between 6 March 1993 and 7 June 1998 approximately 110 hours were spent on 53 surveys.

Although some calling owls may have been unmated males, it is more typical for one to be holding a territory with an associated female (Cannings 1993; Swengle and Swengle 1987). Thus, for the purpose of this study each calling male was considered to represent a breeding pair. The maximum number of calling individuals within an area at any one time was determined by repeated visits to the same place. The density for that selected representative area and plant association was calculated and then multiplied by the amount of similar habitat area on the island to approximate the total island population of Saw-whet Owls.

To obtain breeding biology information, I constructed and erected 7 nest boxes in 1993 each with overall inner dimensions of 6"x6"x12", 18 in 1994 and 17 in 1995 with overall inner dimensions of 8"x8"x15". The specific dimensions of nest boxes are given in Appendix A. I placed 1-2 inches of wood shavings in the bottom of each nest box and then positioned single boxes 3-4 meters off the ground on trees in various habitats. Nest boxes were inspected from 1 to 3 times during the expected breeding season. On each visit signs of occupancy (egg-shell fragments, feathers, cached food, pellets) were recorded as well as the presence of eggs and chicks. Food habits were determined from analysis of prey remains and skeletal elements in regurgitated pellets found in the nest boxes.

## **CHAPTER 4**

### **RESULTS**

The surveys indicated that Saw-whet Owls occurred in pine forests, oak woodlands and eucalyptus groves; as expected, none were detected in associated chaparral, coastal sage or grassland areas that were included in the study.

Bishop pine forests occur on north-facing slopes in three general locations on the island (Figure 1), at the eastern end near Chinese harbor, along the northern coast at Pelican Bay and the western end at upper Canada Cervada including isolated populations extending southward toward Sierra Blanca. The east and west forests have a wide range of tree size and age with the west forest having great amounts of ground litter. The north forest is open with fewer shrubs and lacks intermediate age trees and all forests appear to have healthy regeneration after the numerous decades of grazing. An area of oak woodland immediately adjacent to the west pine forest was included when calculating the density of owls in this habitat.

In the west pine forest, the maximum number of 7 calling males was detected (Figure 2) 18 March, which was one of 10 surveys conducted between 4 December and 7 April. Since logistics prevented an equal number of visits to all three pine forest areas on the island, the east and north pine forests were visited enough to determine Saw-whet Owl presence. At least one Saw-whet Owl was detected on two separate

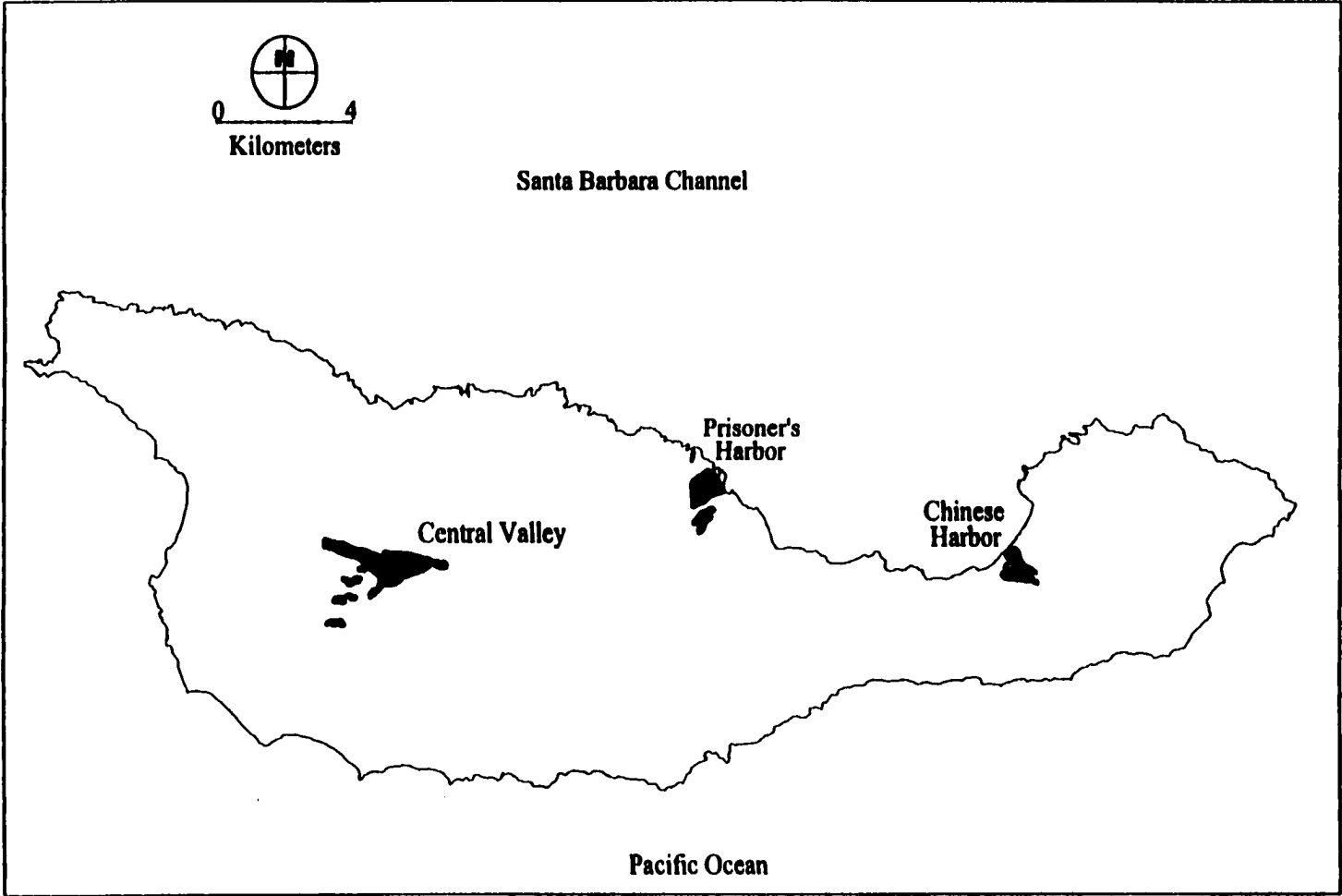


Figure 1. Pine forest locations on Santa Cruz Island

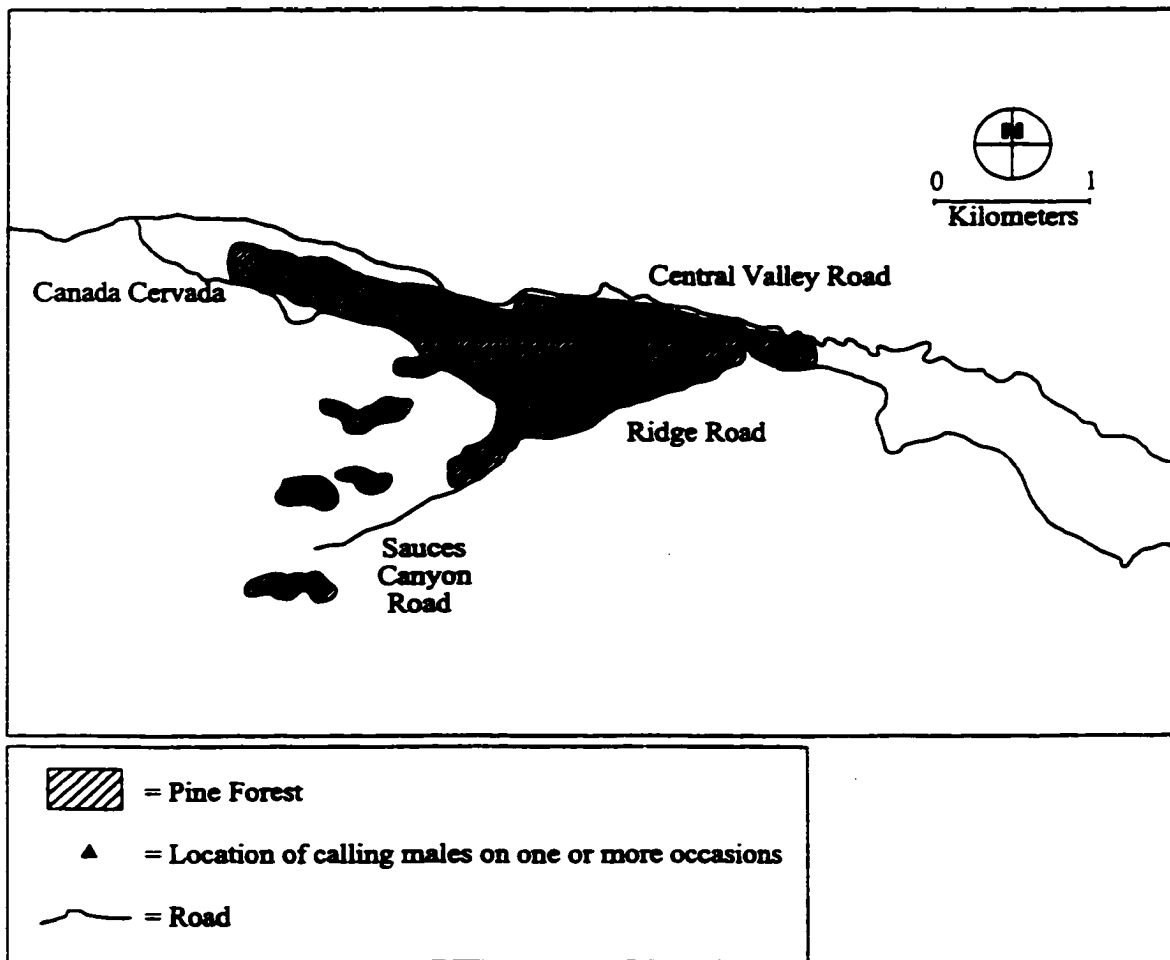


Figure 2. Locations of calling males in western pine forest

occasions in each. Population size for the east and north pine forests was calculated using the density of the west forest and total pine forest area (Minnich 1980). The density was calculated to be 3.7/km<sup>2</sup> and the island wide population in this habitat estimated to be 40 individuals (Table 1).

Oak woodland areas, typically made up of *Quercus agrifolia* with large canopies, were found localized across the island primarily in canyon bottoms and drainages. Large contiguous areas of oak woodland exist only in Prisoner's Harbor canyon, 11 drainages of the north slope, and in upper Canada Cervada in the Central Valley (Figure 3). Numerous small non-contiguous areas of oak woodland were found in Prisoner's Harbor canyon, the Central Valley and the eastern part of the island (Figure 3).

Oak woodlands in five of the north coast drainages were surveyed and single note calls from 8 territorial males were detected (Figure 4). The density of owls in these areas was 11.4/km<sup>2</sup>. The oak woodland in the 6 unsurveyed north coast drainages had an area of 0.8 km<sup>2</sup> and at the same density could have had a population of 9 additional breeding pairs of Saw-whet Owls (Table1).

In addition, approximately 50 smaller non-contiguous stands of Oak woodland ranging in size from one or two trees up to a few dozen trees and an area of 0.004 km<sup>2</sup> were surveyed (Figures 4 and 5). Calling Saw-whet Owls were detected in only 7 of 50 of these smaller areas that were surveyed. Typically owls were detected on only

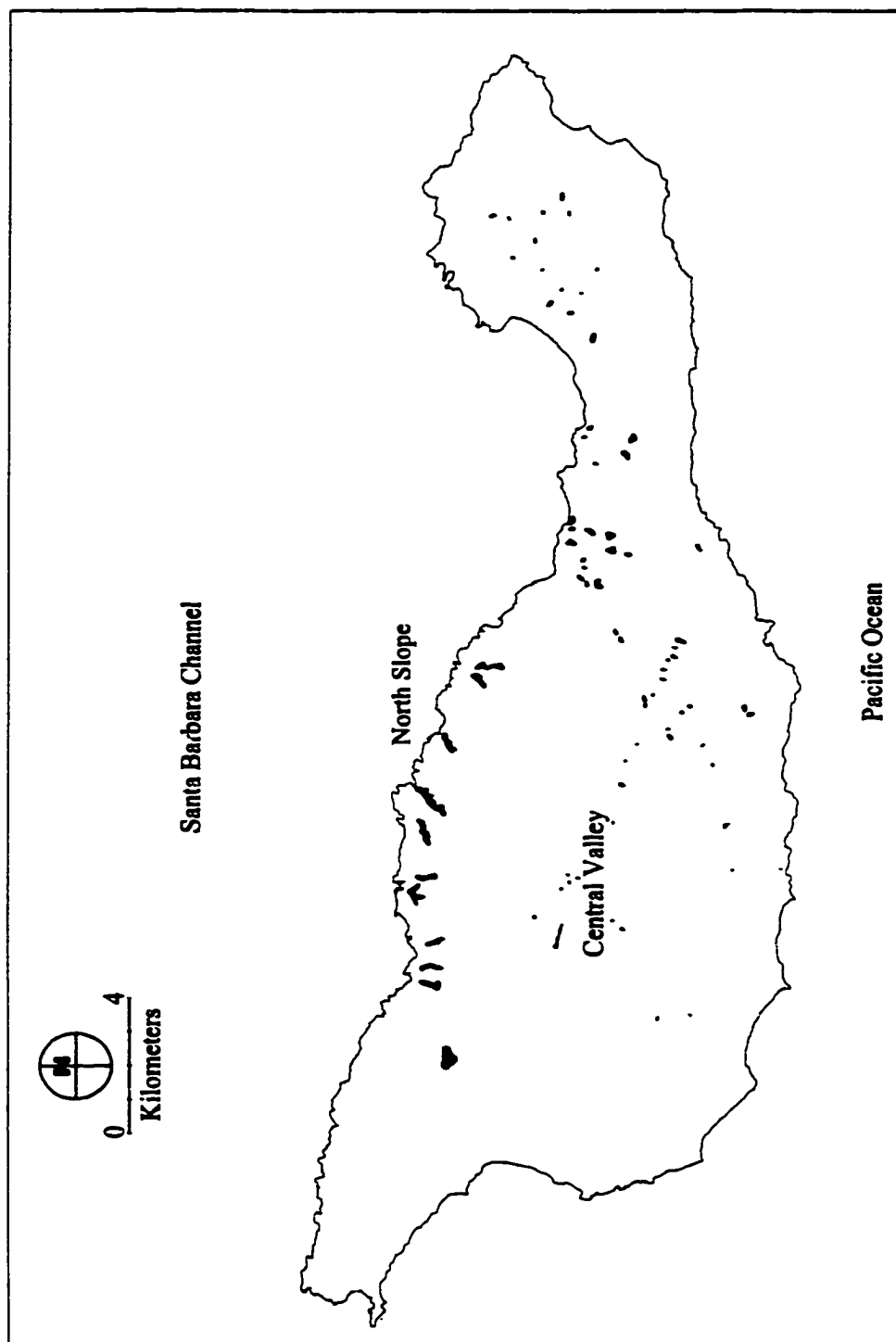
Table 1. Saw-whet Owl Population Calculations

Habitat	Observed Number of Calling Males	Area of Surveyed Habitat (km <sup>2</sup> )	Density (per km <sup>2</sup> )	Total Area of Habitat on Island (km <sup>2</sup> )	Total Calling Males	Total Island Population
Pine	7	1.9	3.7	5.3*	20	40
Oak						
contiguous	8	0.7	11.4	1.5†	17	34
scattered**	7	-	-	-	(21)	(42)
Eucalyptus	16	0.3	53.3	0.3†	16	32
TOTAL					53-74	106-148

\* from Minnich 1980

\*\* possibly not breeding birds (see text)

† calculated using digitized USGS Quadrangle 7.5 minute series (topographic)



**Figure 3. Oak woodland locations on Santa Cruz Island**

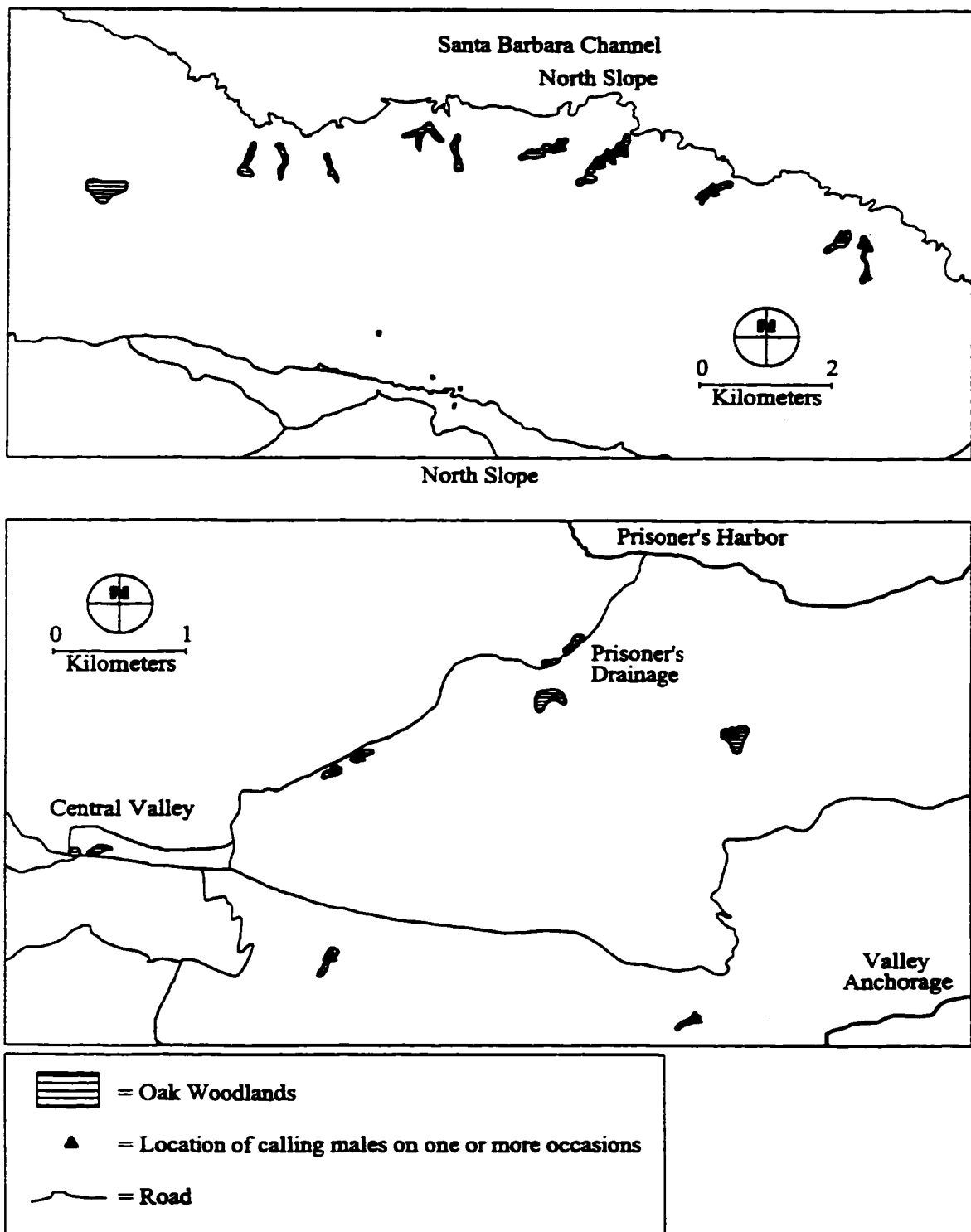


Figure 4. Locations of calling males in surveyed oak woodland

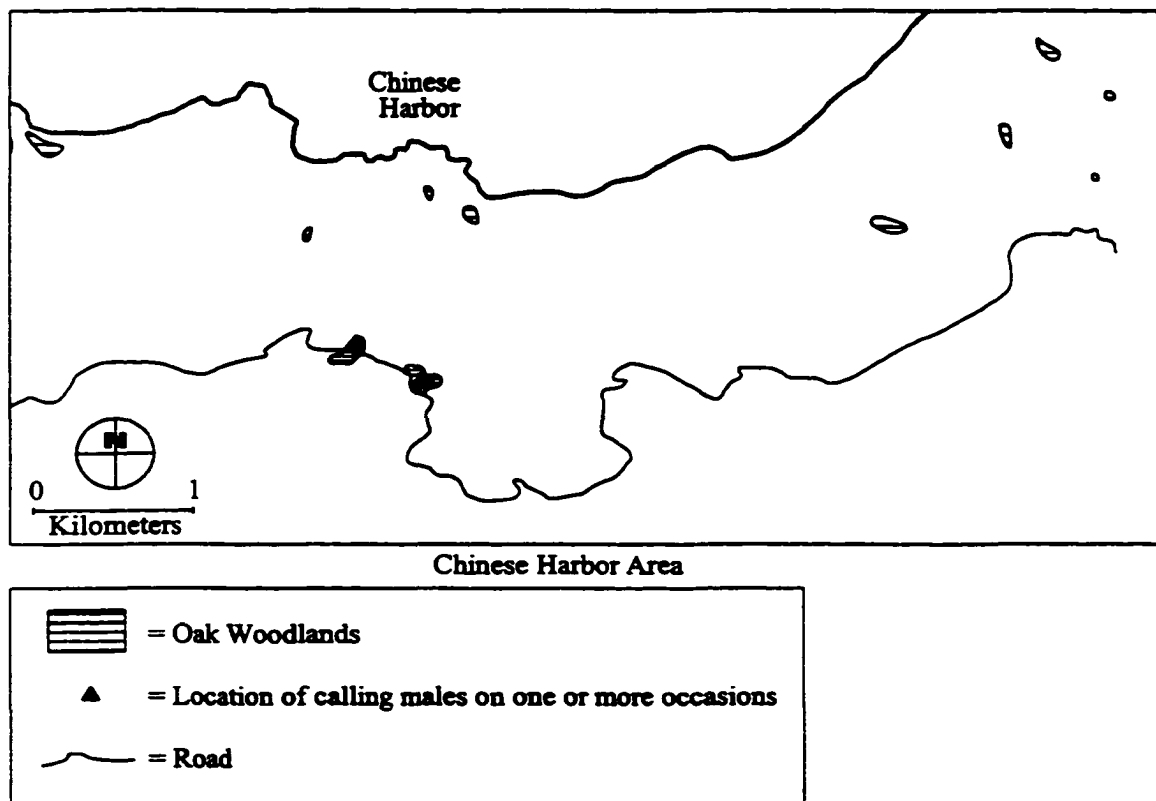


Figure 5. Locations of calling males in surveyed oak woodland-Chinese Harbor area

one or two occasions in these areas. Eight nest boxes were located in 6 of these smaller oak areas but only one was utilized by Saw-whet Owls. This suggests that the calling owls in these areas may not in fact have represented breeding pairs but perhaps dispersing males trying to establish territories in sub-optimal habitat. Mated males, and particularly unmated males, in appropriate breeding habitat would have been expected to call more consistently and continue late in the season. The inconsistent calling and lack of use of nest boxes support the suggestion that these were in fact non-territorial wandering males. However, if these scattered oak clumps were to be included as breeding habitat and they were used by the owls at the frequency observed in these surveys, only 21 pairs would be added to the estimated island-wide population (Table 1).

One male was detected calling on one occasion in a scrub oak area within chaparral habitat. Although only one extensive area of scrub oak was surveyed numerous times, scrub oak existed within detection limits of almost every survey point. Therefore, scrub oak habitat was regularly surveyed during pine, oak woodland and eucalyptus surveys. Scrub oak may be suitable for foraging but the tree trunk diameter is unsuitable for providing nesting cavities. No breeding population was ascribed to this habitat.

Eucalyptus was brought to the island for timber many years ago and planted for windbreaks. Eucalyptus groves are located in three general areas on the island: the Central Valley near the main ranch and field station, the canyon draining the Central

Valley to Prisoner's Harbor, and the mouth of Canada Cervada near Christy Ranch (Figure 6). The eucalyptus trees on Santa Cruz Island have grown to an exceptional height of well over 100 feet. The dense upper canopy layer creates a dark, open understory with deep leaf and bark litter.

One of the major eucalyptus groves at Prisoner's Harbor was uniquely fringed by mature oak. In fact, 2 of the 5 males detected were heard calling primarily from eucalyptus but utilized nest boxes attached to adjacent oaks. Since the oaks were an integral part of the eucalyptus grove, the fringing oak area was treated as part of the eucalyptus grove for the density calculation of this area.

A total of 16 calling males was detected in the eucalyptus groves (Figure 7). The density was calculated to be  $53.3/\text{km}^2$  and the island wide population in this habitat estimated to be 32 (Table 1). The maximum number of calling males was detected on several occasions in all groves between 6 January and 6 April. Most of eucalyptus areas were surveyed and therefore this is closer to the maximum island population for this habitat. The sum of the total island population for all of the three habitat types is 106 individuals (Table 1). The total would be 148 if the owls detected in scattered oak woodland clumps are assumed to also represent part of the breeding population.

Saw-whet Owls responded to imitated single note calls ("elicited calling" herein) as early in the fall as 30 September. They were first detected calling without prior imitations ("non-elicited" calling herein) on 14 October. Approximately 50% of

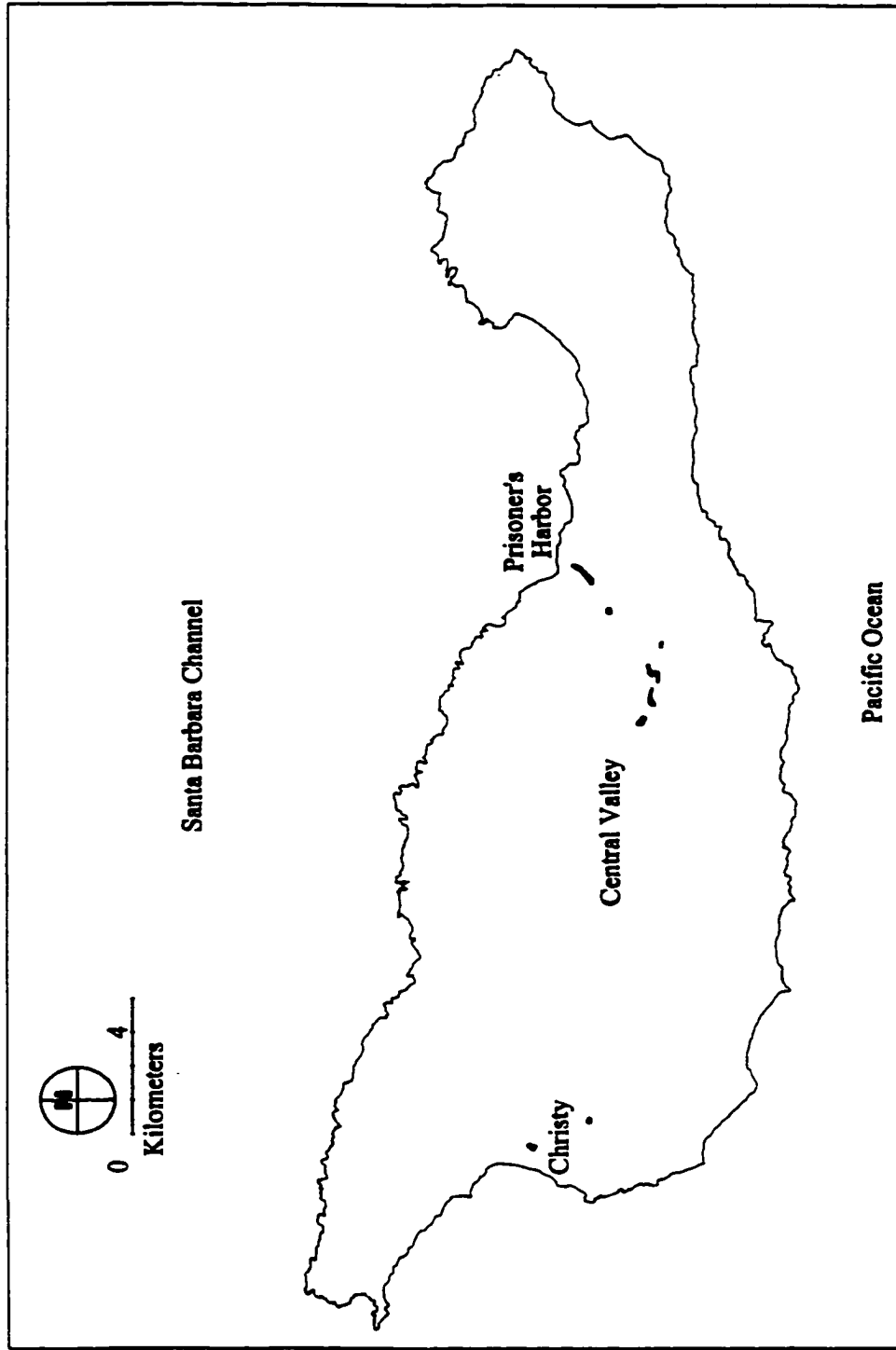


Figure 6. Eucalyptus grove locations on Santa Cruz Island

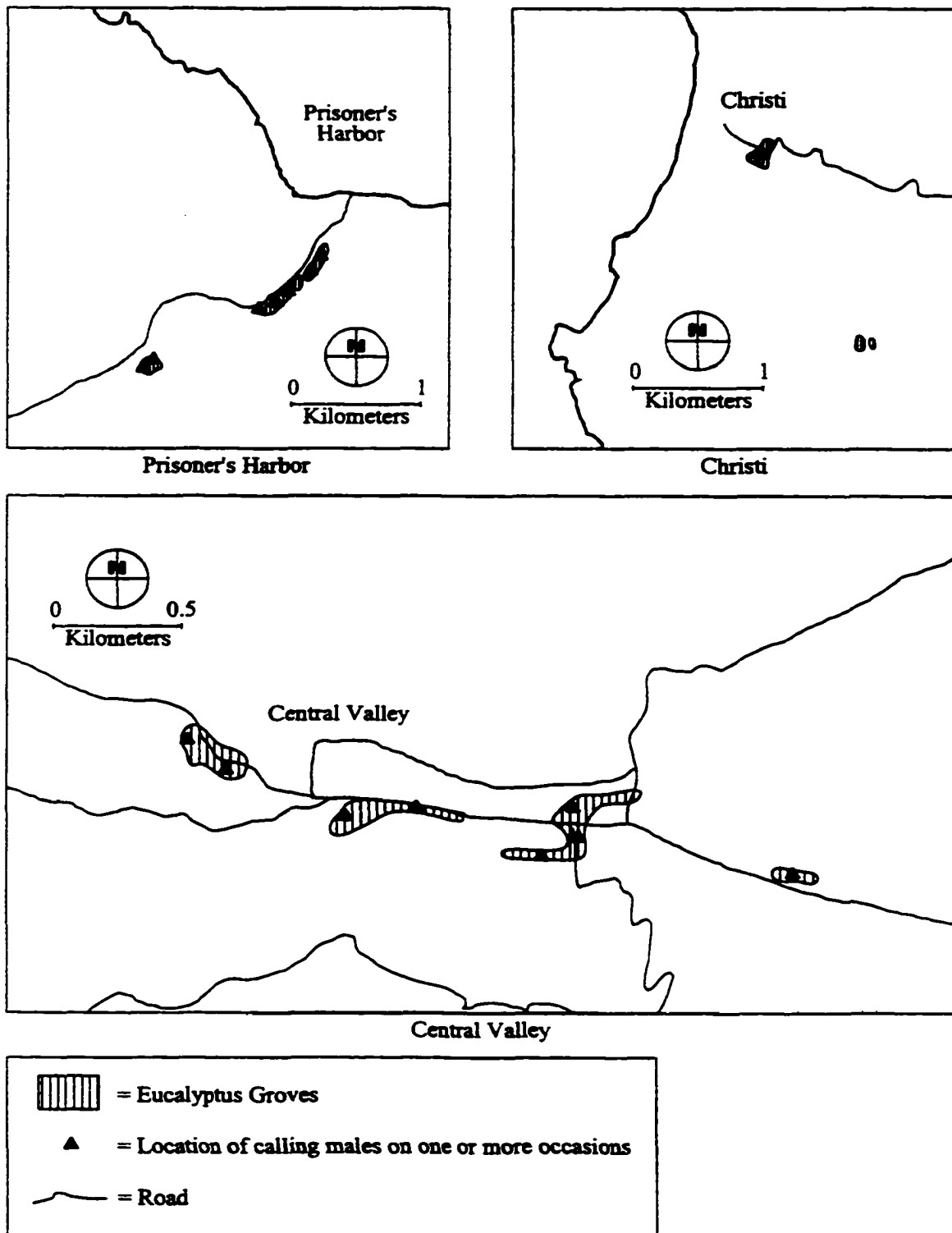


Figure 7. Locations of calling males in eucalyptus groves

the calls detected on 6 January were non-elicited (Figure 8). The peak of the calling season was during the period from 6 March through 7 April when nearly all detected calls were non-elicited; one exception was on 20 January in the eucalyptus grove near Prisoner's Harbor when 100% of the maximum number of individuals were detected by non-elicited calls. Calling tapered off during April and was rarely detected after 27 April. The latest non-elicited calling by Saw-whet Owls was on 15 June and no owls were detected calling during July surveys. No surveys were conducted during August.

Although other vocalizations were heard, the single note call described in Cannings (1993) was the only vocalization used to determine Saw-whet Owl presence. I heard 4 of the 9 calls described by Cannings (1993): 1) the single note call, given primarily by advertising males; 2) a nasal whine; 3) a short series of loud screeching calls, given by both sexes; and 4) a short insect-like buzz (Collins 1993).

The single note calls, both elicited and non-elicited, ranged widely in duration, frequency, and intensity. The calls appeared to start with a fast inconsistent rate then slowed slightly and became more rhythmic after several seconds. Often, the first response I received to my imitation of the single note call was the nasal whine or the loud screeching call; the loud screeching was usually given when the owl was closer to my location. Elicited calling sometimes triggered adjacent territory holding males to initiate the single note call. On one occasion I heard a whine followed immediately by several clicks, similar in sound to bill snaps. The insect like buzz was heard on only

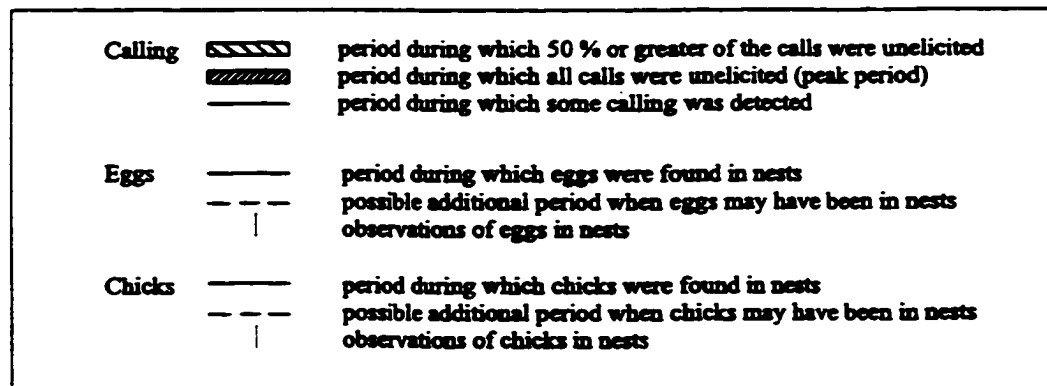
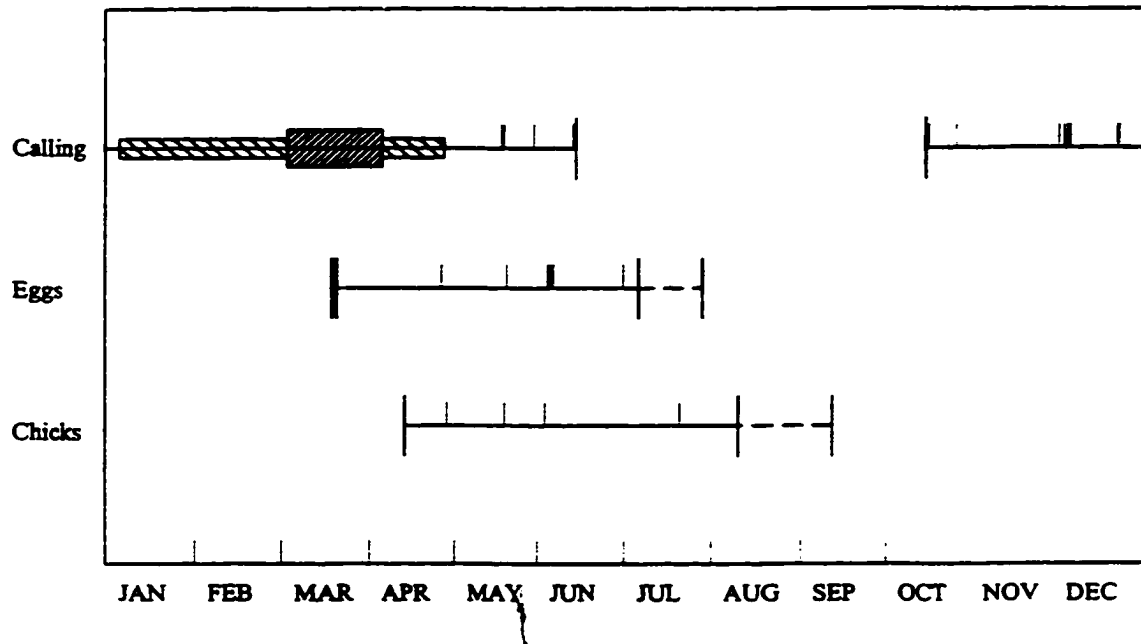


Figure 8. Breeding phenology of Saw-whet Owls on Santa Cruz Island

two occasions. Once, it was given during the early breeding season when two adults, presumably male and female, were observed sitting inches apart on a branch not much above head height. This is contextually different from its previously described role in threat displays (Collins 1993).

A total of 42 nest boxes were installed and monitored during the 1995, 1996 and 1998 breeding season for a total of 90 nest box years (Table 2). Nest box locations within habitat types are shown in Figures 9-13. Of the 90 nest box years, 65 were utilized by Saw-whet Owls and other species including American Kestrel (*Falco sparverius* Linnaeus), Ash-throated Flycatcher (*Myiarchus cinerascens* (Lawrence)), House Wren (*Troglodytes aedon* Vieillot), Northern Flicker (*Colaptes auratus* (Linnaeus)), European Starling (*Sturnus vulgaris* Linnaeus), giving an overall success rate of 72 %. Saw-whet Owl utilization accounted for only 17 nest box years (19%) with 11 (12%) being documented breeding; 4 in 1995, 3 in 1996 and 4 in 1998 (Table 3). Six of the 17 nest box years were occupancies determined by feathers, egg-shell fragments and food items and provided no detailed information on breeding.

Nest boxes 22 and 25, located in the eucalyptus grove near Prisoner's Harbor, were both used by Saw-whet Owls in consecutive years, 1995 and 1996. It is not known if the same female used the same nest box both years.

Clutch initiation dates ranged from early March to early June, possibly to late June, with the number of eggs per nest box ranging from 2 to 5. Several of these were thought to be incomplete clutches so no mean clutch size was calculated. Chicks were

**Table 2. Nest Box Utilization on Santa Cruz Island**

**Legend**

<b>SW-Oc</b>	<b>= Occupied by Saw Whet-Owls (eggshells, pellets, feathers) but no information on breeding</b>
<b>SW-B(e)</b>	<b>= Saw-whet Owl breeding documented (eggs)</b>
<b>SW-B(y)</b>	<b>= Saw-whet Owl breeding documented (young in nest box)</b>
<b>SW-B(f)</b>	<b>= Signs of Saw-whet Owl young fledged</b>
<b>Nm</b>	<b>= Nesting material by other unidentified species</b>
<b>0</b>	<b>= Nest box not occupied</b>
<b>–</b>	<b>= Nest box not checked, damaged or not installed</b>
<b>AMKE</b>	<b>= American Kestrel</b>
<b>ATFL</b>	<b>= Ash-throated Flycatcher</b>
<b>HOWR</b>	<b>= House Wren</b>
<b>NOFL</b>	<b>= Northern Flicker</b>
<b>EUST</b>	<b>= European Starling</b>

Table 2. Nest Box Utilization on Santa Cruz Island

Nest Box #	Habitat Type	1995	1996	1998
1	Pine	-	-	-
2	Pine	NOFL	AMKE	-
3	Pine	0	0	0
4	Pine	AMKE	AMKE	0
5	Pine	AMKE	AMKE	0
6	Pine	AMKE	0	0
7	Pine	-	0	0
8	Eucalyptus	SW-B(f)	0	NOFL
9	Eucalyptus	nm	0	0
10	Oak	nm	0	ATFL
11	Eucalyptus	HOWR	nm	0
12	Eucalyptus	HOWR	nm	NOFL
13	Eucalyptus	0	0	NOFL
14	Eucalyptus	ATFL	SW-Oc	ATFL
15	Eucalyptus	nm	nm	0
16	Eucalyptus	NOFL	nm	-
17	Eucalyptus	NOFL	SW-B(f)	NOFL
18	Eucalyptus	NOFL	SW-B(e)/nm	NOFL
19	Oak	SW-B(e)/nm	nm	AMKE
20	Oak	AMKE	AMKE	-
21	Eucalyptus	SW-B(y)	SW-Oc	0
22	Eucalyptus (Oak)	SW-B(e&y)	SW-B(y)	NOFL
23	Eucalyptus	-	-	-
24	Eucalyptus (Oak)	0	SW-Oc	SW-B(e)
25	Eucalyptus	SW-B(e)	SW-B(e)	NOFL
26	Eucalyptus	-	SW-Oc	SW-Oc/EUST
27	Eucalyptus	-	-	-
28	Eucalyptus	-	nm	SW-B(e)
29	Eucalyptus	-	AMKE	0
30	Eucalyptus	-	AMKE	NOFL
31	Eucalyptus	-	0	SW-B(e&y)
32	Eucalyptus	-	0	SW-B(e)
33	Eucalyptus	-	HOWR	-
34	Eucalyptus	-	nm	0
35	Eucalyptus	-	-	-
36	Eucalyptus	-	-	-
37	Oak	-	EUST	0
38	Oak	-	EUST	AMKE
39	Pine	-	AMKE	-
40	Pine	-	nm	-
41	Oak	-	0	ATFL
42	Oak	-	NOFL	AMKE

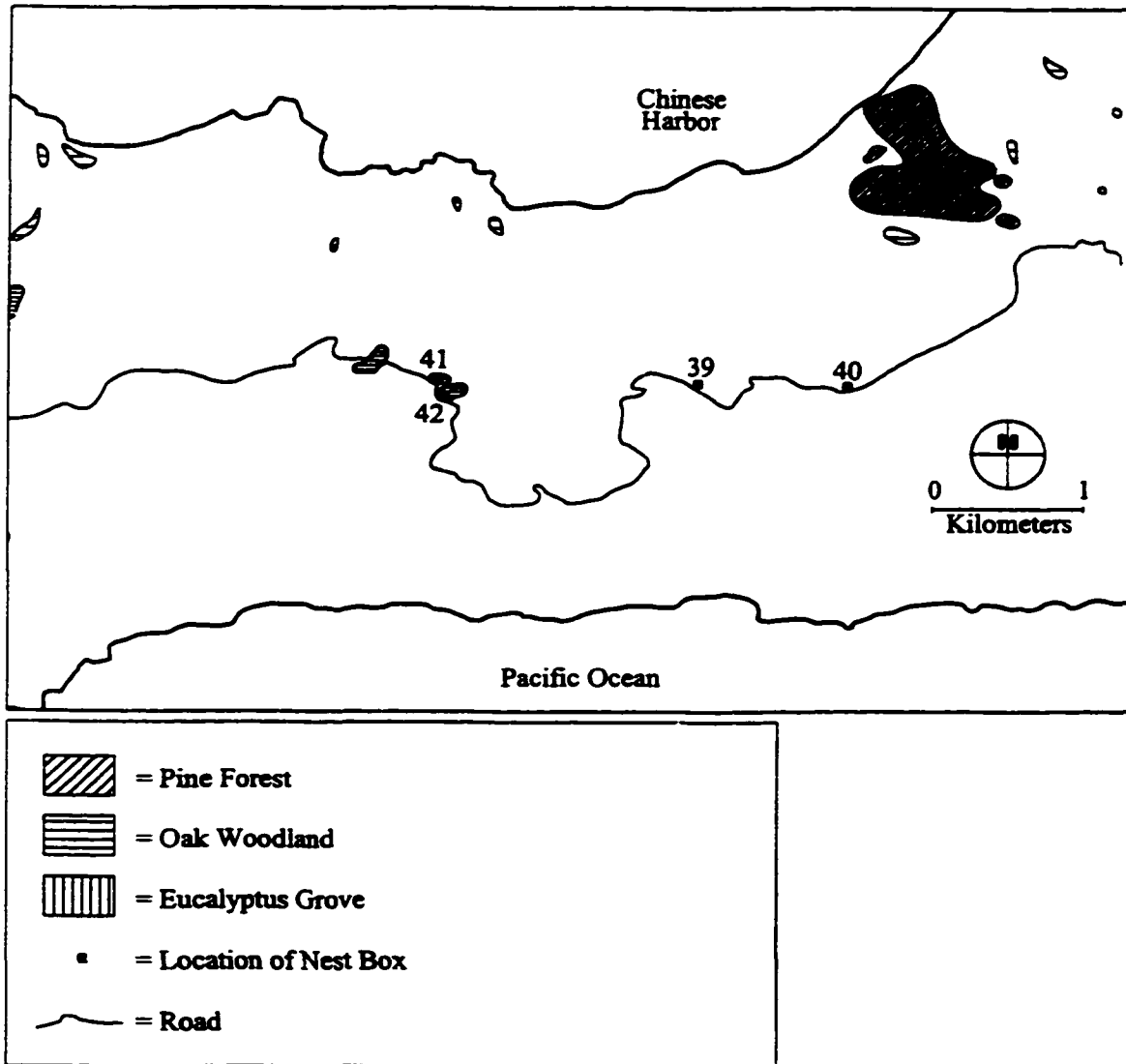


Figure 9. Nest box locations at east end

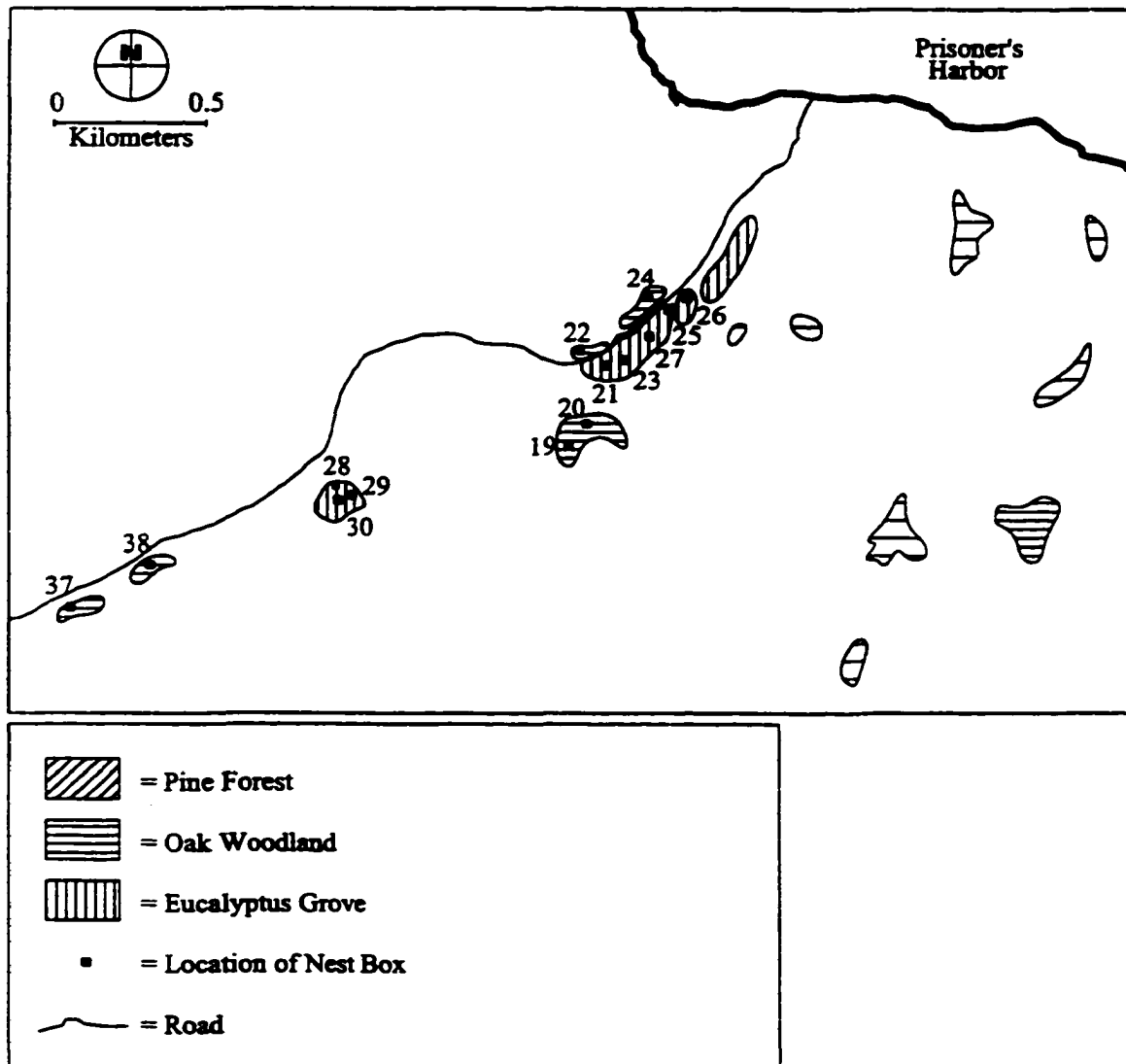


Figure 10. Nest box locations in Prisoner's drainage

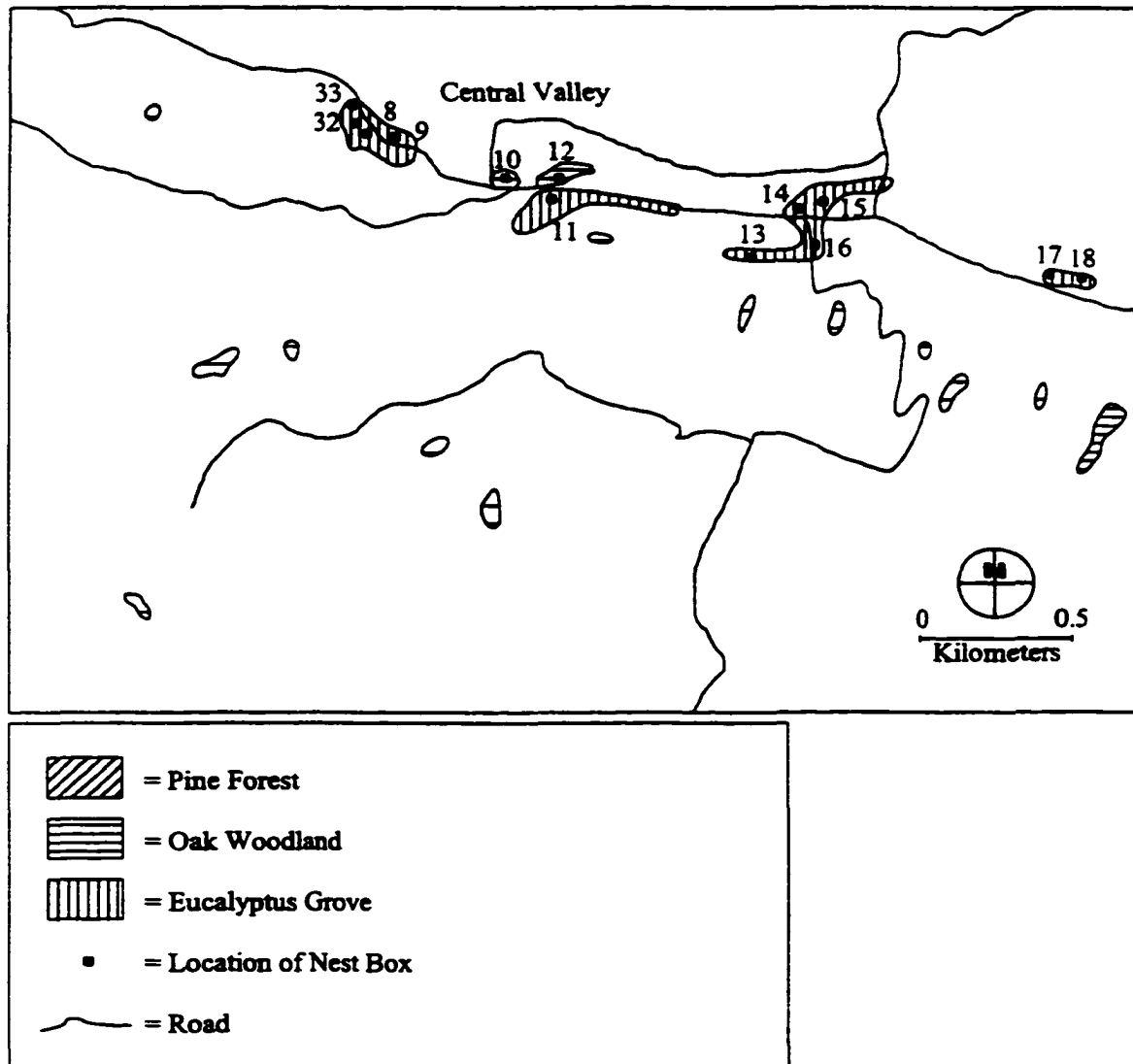


Figure 11. Nest box locations in central valley

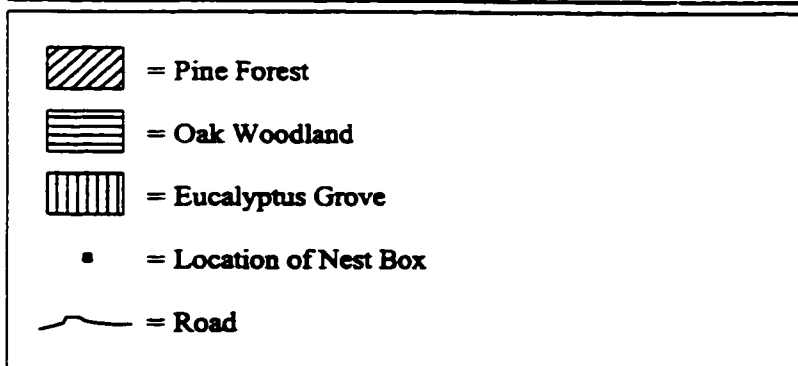
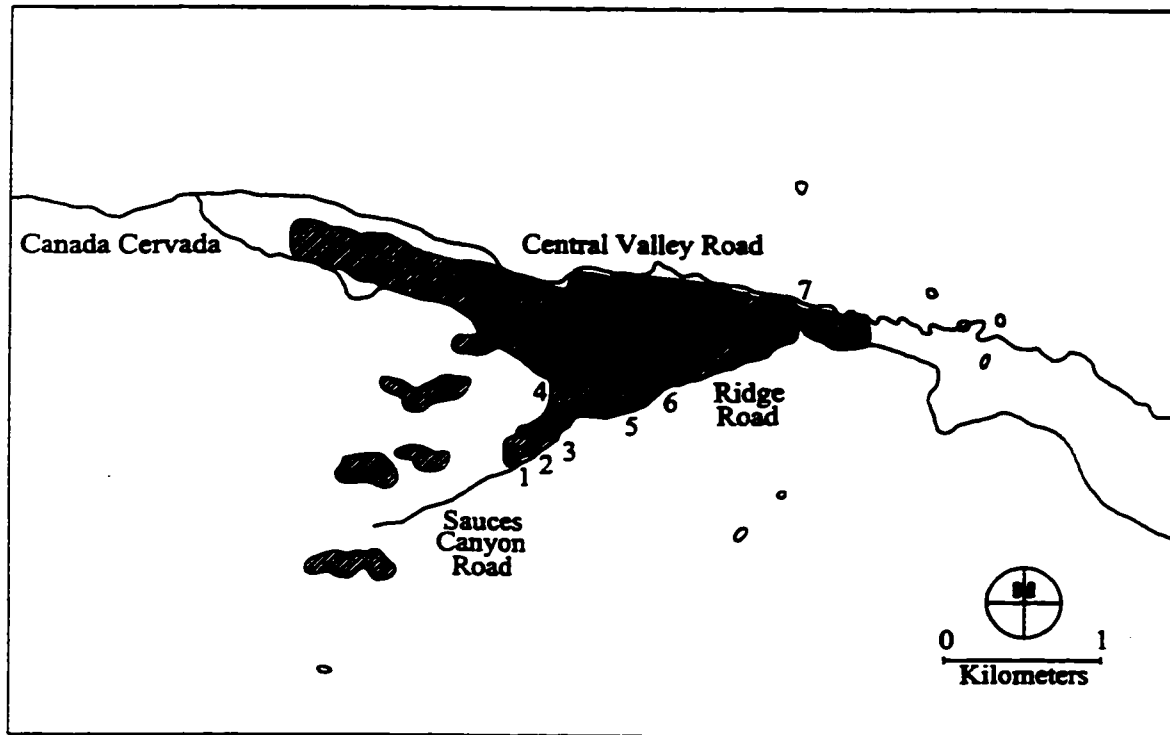


Figure 12. Nest box locations in western pine forest

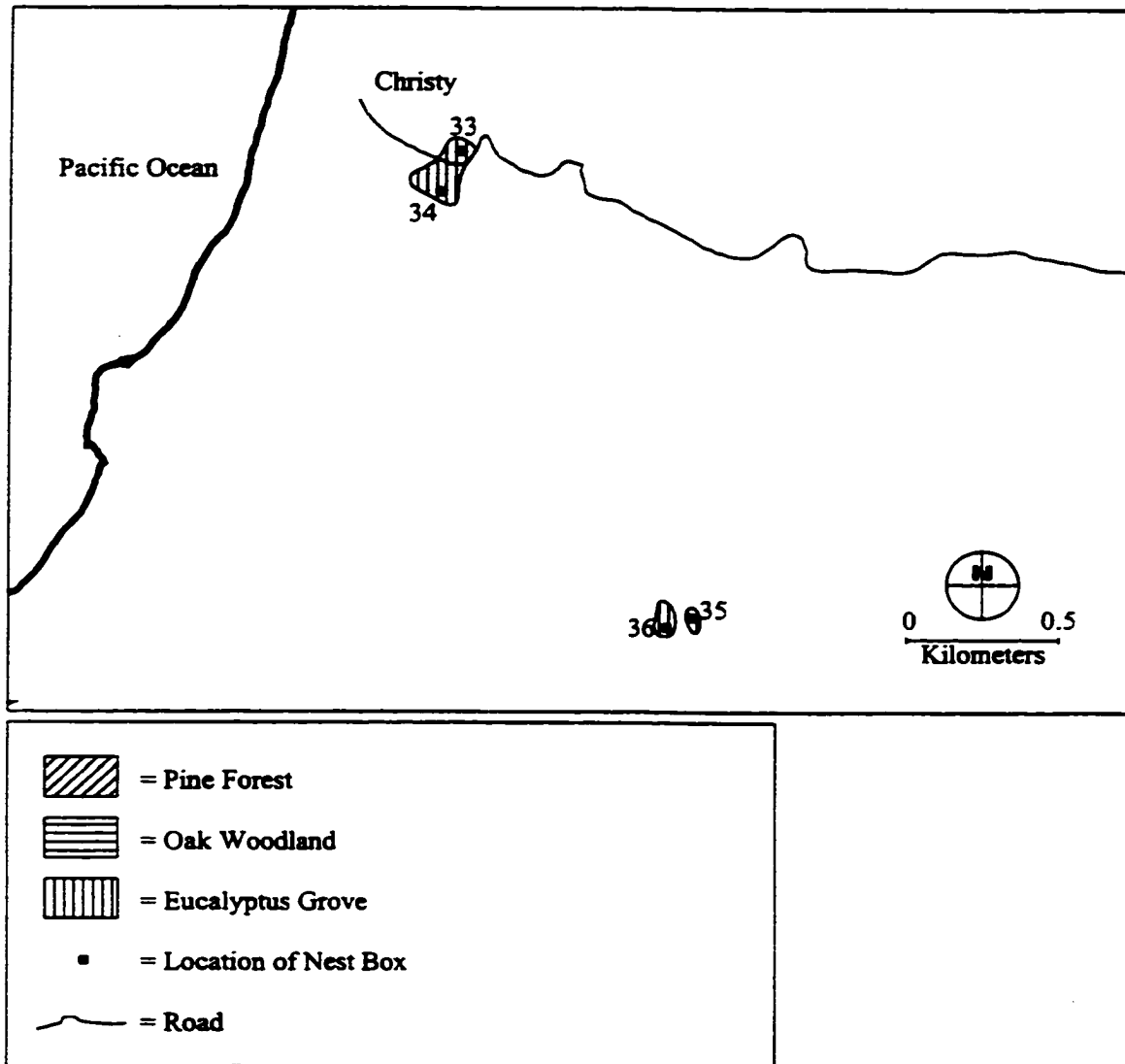


Figure 13. Nest box locations at west end

**Table 3. Saw-whet Owl Breeding Observations**

<b>Nest Box #</b>	<b>Date</b>	<b>Observation</b>
18	27 April 1996	2 eggs
19	02 July 1995	4 eggs
21	23 July 1995	1 egg, 2 young (2 wks old)
22	21 May 1995	1 egg (pipped), 1 young
22	29 April 1996	6 young (youngest 3 days old)
24	07 June 1998	3 eggs
25	21 May 1995	3 eggs
25	27 April 1996	4 eggs (2 translucent pink)
28	06 June 1998	2 eggs
31	05 June 1998	5 eggs, 1 young
31	07 June 1998	4 eggs, 2 young
32	05 June 1998	2 eggs
32	07 June 1998	3 eggs

found on 21 May 1995, 23 July 1995, 29 April 1996 and 7 June 1998 in nest boxes 22, 21, 22 and 31 with brood sizes 1 (plus 1 pipped egg), 2, 6, 2, respectively. Cannings (1987, 1993) indicated incubation period of 27-29 days, hatching at 2-day intervals and a fledging period of 29-36 days for Saw-whet Owls. Using these figures, the estimated breeding phenology of Saw-whet Owls on Santa Cruz Island is presented in Figure 8.

Although unquantified, most of the pellets and food items indicated the diet of Saw-whet Owls on Santa Cruz Island to consist primarily of deer mice (*Peromyscus maniculatis*) and a few insects. One bat wing was found in nest box #19 and identified by long bone measurement comparisons as either hoary bat (*Lasiurus cinereus*) or pallid bat (*Antrozous pallidus*).

## **CHAPTER 5**

### **DISCUSSION**

A total of 33 Saw-whet Owl breeding territories was detected in pine, oak and eucalyptus habitats during the study period 1993-1998. They occurred in each of the three pine forest areas on the island, in the larger contiguous areas of oak woodland scattered across the island and in all areas of eucalyptus found in the central valley and Prisoner's Canyon.

Elsewhere, Saw-whet Owls are typically associated with coniferous forests and thus were expected to occur in the pine forest areas on Santa Cruz Island in comparable densities to other parts of their range. The density in the west pine forest was determined to be 3.7/km<sup>2</sup>; less than the 12.9 pairs/km<sup>2</sup> reported by Swengle and Swengle (1987). The west pine forest can be classified as a senescent forest with numerous snags and is just starting to show signs of regeneration. The west pine forest differed from the other pine forests in a greater number of large diameter trees present. This may have led to a higher density of nesting Saw-whet Owls there than in other pine forests on the island. Accordingly, the island wide estimate for Saw-whet Owls in this habitat (Table 1) is probably near a maximum. Other pine forest areas on the island have relatively recently been relieved of grazing pressures and may, in time, become similar in structure to the west forest.

Saw-whet Owls are not typically known to inhabit oak woodlands but it is no surprise they do so on Santa Cruz Island since they are found in canyons of the Santa Ana Mountains (Hamilton and Willick 1996). The calculated density of 11.4/km<sup>2</sup> for the north coast drainage area is probably the best estimate for large contiguous oak habitat on Santa Cruz Island. The 6 remaining oak areas on the north coast should be censused to determine owl presence and the validity of the assumption that owls occur here at equal density to the 5 north coast areas already censused. Additional small areas of scattered oak woodland should also be looked at again to determine if breeding occurs, what minimum size area will support a breeding pair of Saw-whet Owls, and if proximity to larger contiguous oak areas or riparian areas are important in determining oak clump occupancy.

On Santa Catalina Island the majority of Saw-whet Owls were located along large canyon system riparian zones in “moist areas with multi-layered vegetation canopies containing large trees, and where adjacent coastal sage scrub communities exist” (Garcelon and Romsos 1994). The large canopy trees in these areas where *Quercus agrifolia* does not occur are *Prunus ilicifolia*, closely resembling *Quercus agrifolia* in appearance.

Although Saw-whet Owls are widely recognized by researchers visiting Santa Cruz Island to utilize eucalyptus groves, owl density has not been calculated. The density for eucalyptus habitat determined by this study is 53.3/km<sup>2</sup>; several times that of the estimated densities in other parts of its range. In a survey of *Peromyscus*

distribution on the island, mice appeared to be in higher densities in riparian areas (R. Mayfield, pers. comm) which may partially explain this higher owl density since most of the eucalyptus areas are located adjacent to riparian areas.

A perceived lack of low hunting perches and few observable nesting cavities suggested that Saw-whet Owls would use eucalyptus trees primarily for calling and would be expected to have a lower density there than in pine forests on the island. Low hunting perches may not be as scarce as once thought. Two juveniles, presumably fledged from nest box #22, were observed roosting side by side on a small piece of peeling eucalyptus bark less than 2 meters from the ground. Saw-whet Owls on Santa Cruz Island make extensive use of eucalyptus woodlands but maybe partially restricted by the lack of nest cavities. On Santa Catalina Island the only 2 nests located were both in nest boxes (Garcelon and Romsos 1994).

The population of Saw-whet Owls on Santa Cruz Island is estimated to be between 53 and 74 pairs (106-148 individuals). Much of this variation is related to the uncertainty about Saw-whet Owl utilization of small, scattered bits of oak woodland. The population of Saw-whet Owls on Santa Catalina Island was estimated to be 29 pairs (58 individuals) (Garcelon and Romsos 1994) which is more consistent with the lower end of the range estimated for Santa Cruz Island.

On Santa Cruz Island, Saw-whet Owls have a greatly extended calling period. Occasional non-elicited calls were recorded from 14 October to 15 June. The calling period when more than 50% of the maximum individuals present gave non-elicited

calls extended from 6 January through 27 April. Elsewhere in their range Saw-whet Owls typically call from late January to late April with a peak from late February to April (Cannings 1993; Palmer 1987; Swengle and Swengle 1987). Unmated males may call somewhat longer than mated individuals (Cannings 1993).

In this analysis of these owls at the southern end of their range, the breeding biology is in most respects similar to that reported in other parts of the range. The egg laying period appears to be within the range, early March through early June, given by Cannings (1993) for other more northerly study areas. However, I found evidence of Saw-whet Owls having already fledged from nest box number 8 on 21 May 1995, my first inspection of the box that season. The exact date of fledging was not known so it was not possible to determine the exact egg laying period, but it may well have been earlier than March.

Saw-whet Owl clutch size is usually 5 or 6 eggs, less commonly 4 or 7, throughout North America with smaller average clutches along the Pacific coast (museum collections referenced in Cannings 1993). Although several clutches observed in this study were probably incomplete at the time of observation, two complete clutches of 2 eggs and one of 3 eggs were observed. Thus it is possible that Saw-whet Owls have a smaller average clutch size on Santa Cruz Island than mainland and northern breeding populations. A trend towards K selected reproduction and smaller clutch size has previously been noted in the Island Scrub-Jay (*Aphelocoma insularis* Henshaw) (Atwood 1980) and other island inhabiting birds (Cody 1966).

Saw-whet Owls often forage in dense woodland habitats where they utilize auditory cues to locate their largely small mammal prey (Cannings 1993; Frost, Baldin and Csizy 1989). As expected, their diet on Santa Cruz Island was primarily deer mice (*Peromyscus*) and some insects. Deer mice are the only small mammals on most parts of the island with only a few harvest mice (*Reithrodontomys megalotis*) being found in localized areas at the western end (Mayfield pers. comm). Bats are an unexpected food item for Saw-whet Owls but have been documented as an uncommon food item on the mainland as well (Cannings 1993). Long bone comparisons indicate the bat wing found in nest box #19 was from either *Antrozous pallidus* or *Lasiurus cinereus*, both of which are present on the island (Brown 1980). *Antrozous pallidus* is more likely as it regularly forages on the ground and would thereby provide auditory cues for a foraging Saw-whet Owl.

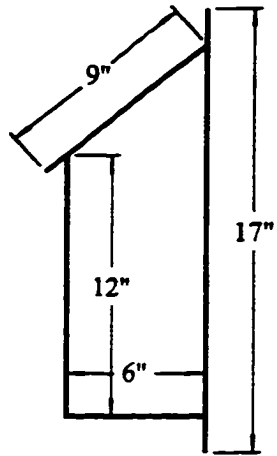
This study indicates Saw-whet Owls both exist on Santa Cruz Island in good numbers and are breeding. The extended calling period indicates the owls are definitely present on the island throughout most of the year and should be considered permanent residents on the island and non-migratory. The Saw-whet Owl has been sparsely but regularly recorded since first noted in 1931. Although there are no previous studies of population numbers of these owls on Santa Cruz Island, there is no reason to suspect their population size has varied substantially in at least recent decades. Nest sites on Santa Cruz Island may be in short supply despite an abundance of hole-excavating Northern Flickers (C. Collins, pers. comm). However, the nest

boxes erected in this study were not all utilized and are unlikely to have influenced the number of breeding pairs of owls, at least during this study.

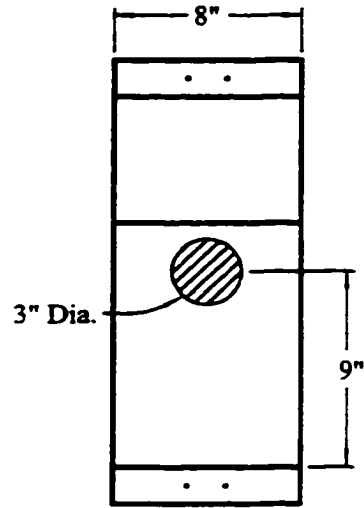
A revised habitat management plan is currently being formulated for Santa Cruz Island. Removal of exotic flora and fauna is an important goal of this plan. Removal of widespread exotics such as fennel (*Foeniculum vulgare*), feral pigs (*Sus scrofa*) and honeybees (*Apis mellifera*) are unlikely to have any impact on Saw-whet Owl numbers unless deer mouse prey populations are also impacted. Similarly, removal of exotic trees such as Brazilian Pepper (*Schinus terebinthifolius*) should not have any effect on the owls. However, should the large stands of eucalyptus trees be included in this program in the future, consideration should be given to the impact on resident Saw-whet Owls which currently make substantial use of this as breeding habitat.

**APPENDIX A**  
**NEST BOX DIMENSIONS**

SIDE

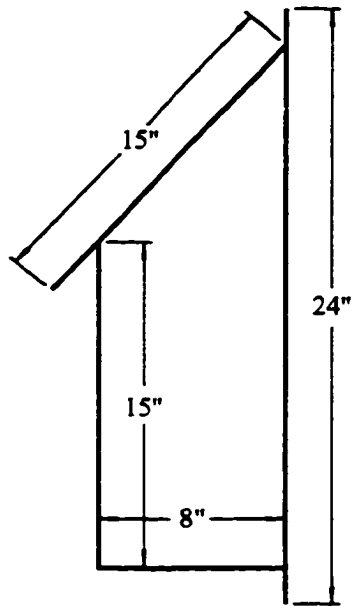


FRONT

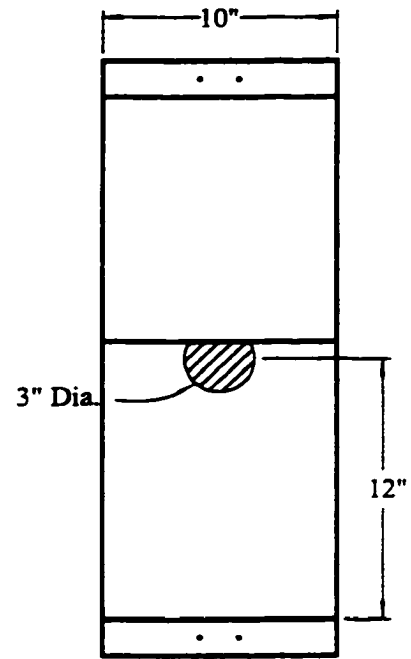


1993

SIDE



FRONT



1994 & 1995

**APPENDIX B**  
**SPECIFIC NEST BOX LOCATIONS**

<u>Nest Box #</u>	<u>Location</u>
1	from nest box #2, south on Sauces road 100 - 150 steps, 30 steps from road to the west, barely visible from road, nest box on large pine tree
2	from nest box #3 south on Sauces road 100 - 150 steps, or from intersection of Ridge road and Sauces road 0.3 mile down Sauces canyon along road, 30 steps from road to the west, barely visible from road, nest box on large pine tree
3	from intersection of Ridge road and Sauces road, 2/10 mile down Sauces road, 30 steps from road to the west, barely visible from road, nest box on large dead pine tree with broken top and few branches
4	from intersection of Ridge road and Sauces road, west 100 steps on Ridge road to where the road levels, 30 steps from road to the north (perpendicular to road), barely visible from road, nest box on south-west side of large pine tree
5	from intersection of Ridge road and Sauces road, east 3/10 mile to gate, easily visible from road, nest box in large dead pine tree on north side of road
6	from nest box gate at #5, east on Ridge road 2/10 mile to where large canyons rapidly drop from both sides of road, easily visible from wooden fence post along north side of road, nest box on large dead pine tree
7	from intersection of Ridge road and Centinella road, north on Centinella road 100 steps from Ridge road, nest box on large dead fallen pine tree on east side of road
8	from intersection of Valley road and road leading to condos, 3rd tree on right along road leading to condos, directly adjacent to road, nest box on south side of eucalyptus tree
9	from east end of Sherwood forest along Valley road, 4th tree on right along Valley road, easily visible from road, nest box on west side of eucalyptus tree
10	on large oak tree on north side of intersection of Valley road and Islay Canyon road

- 11 on small oak tree along road to Lyndal's house, four trees from Valley road
- 12 on large oak tree bordering the clearing on E side of the field station, between fire wood shack and gate to Lyndal's
- 13 from intersection of Valley road and Coches road, south on Coches road about 0.3 mile to a long row of eucalyptus trees extending west, about 30 trees west from white wooden gate on Coches road, approximately at slight high spot in tree line, nest box on east side of eucalyptus tree
- 14 at intersection of Valley road and Coches road, north side of intersection and slightly west, easily visible from road, nest box on tree directly adjacent to road
- 15 from nest box #14, east on Valley road 20 steps, north 15 steps into grove from Valley road, nest box on west side of large eucalyptus tree
- 16 from intersection of Valley road and Coches road, south on Coches road approximately 30 steps (8-10 trees), 2-3 trees in from road, barely visible from road, nest box on north side of eucalyptus tree
- 17 from nest box #18, west 100 steps staying in middle of grove to a clearing area of numerous fallen eucalyptus trees, nest box on west side of eucalyptus tree bordering the east side of clearing
- 18 from east end of eucalyptus grove located east of Ranch along Valley road, approximately 0.1 mile west along old Valley road past where finger of small eucalyptus trees meet the road to an alcove in grove at right turn in road, enter grove through alcove between 2 large fallen eucalyptus trees, 20-25 steps into grove, nest box on north side of large eucalyptus tree
- 19 from road on south side of eucalyptus grove near Prisoner's Harbor, south-east across wash and up small bluff, easily visible from group of dead trees, nest box on large oak in front of small waterfall
- 20 from road on south side of eucalyptus grove near Prisoner's Harbor, south-east across wash and up small bluff, nest box on large fallen oak in 1998

- 21 from south entrance into eucalyptus grove near Prisoner's Harbor, east 10 steps into the grove at a 45 degree angle from road, nest box on west side of road on south side of eucalyptus tree
- 22 from south entrance into eucalyptus grove near Prisoner's Harbor, nest box on back side of first large oak in the west left
- 23 eucalyptus grove near Prisoner's Harbor, never located after installation
- 24 from north entrance into eucalyptus grove near Prisoner's Harbor, easily visible on west side of road, nest box on large oak on steep slope
- 25 from nest box #24, west across wash 10 steps it and to the right from corner of eucalyptus grove, nest box on east side of eucalyptus tree
- 26 from nest box #25, 100 steps down wash toward pier, east (right) into eucalyptus grove 40 steps, within an older dense eucalyptus grove, nest box on east side of eucalyptus tree
- 27 from south entrance into eucalyptus grove near Prisoner's Harbor, north on road toward pier, just after the area of eucalyptus on both sides of road, visible on east (right) side of road, nest box on eucalyptus tree 25 steps from the road
- 28 from north end of the eucalyptus grove between Ranch and Prisoner's eucalyptus grove, enter grove between 2 large eucalyptus trees to the right of the corner most multi-trunked eucalyptus, straight through clearing with several small cut eucalyptus stumps, continue slightly left 30-40 steps beyond clearing, nest box on eucalyptus tree
- 29 from nest box 28, continue to north-east (far left) corner of grove, nest box on back side of large multi-trunked eucalyptus tree at corner of grove
- 30 from clearing with several small cut eucalyptus stumps near nest box #28, south (toward middle of grove) about 20 steps there is a another slight clearing, easily visible on south edge of clearing, nest box on eucalyptus tree facing in toward clearing
- 31 from West end of Sherwood forest along Valley road, 25 steps into grove (poison oak on tree to right), 15 steps South of road, visible from road, nest box on north side of eucalyptus tree

- 32 from nest box #8 20 steps towards nest box #31, nest box on south-east side of eucalyptus tree
- 33 nest box on large multi-trunk eucalyptus tree on north side of bridge, easily visible from north side of tree
- 34 from nest box #33, cross bridge, west side of bridge, nest box easily visible on cypress tree along stream bank
- 35 nest box on north side of large cypress tree in middle of cypress grove
- 36 nest box on north side of large eucalyptus tree located at extreme south-west edge of eucalyptus grove
- 37 from Ranch 0.8 mile along road leading to Prisoner's harbor, where canyon narrows just after numerous large oak trees on steep slope east of road, visible from road, nest box on large oak on east side of creek
- 38 from Ranch along road leading to Prisoner's harbor where canyon opens into area with nest boxes 28-30, oaks along steep face of east side of road, nest box is barely visible from road, through *baccaris* enter small oak grove from the south, once in under-story of oak trees easily visible to the north, nest box on large oak tree
- 39 along road leading to eastern pine forest, where road levels and pine mixed with manzanita, easily visible on north side of road, nest box on large dead pine tree
- 40 along road leading to eastern pine forest, where road levels and pine mixed with manzanita, north side of road within area of many fallen pine trees, nest box on large dead pine tree
- 41 from nest box #39, west 150 steps along road, under 3 large oaks on north side of road, over fence, nest box on large oak tree just other side of fence
- 42 along road leading to Navy station, at single wooden fence post and sign reading "ascending traffic has right away", easily visible from road, nest box on oak on north side of road

## **LITERATURE CITED**

## LITERATURE CITED

- American Ornithologists' Union. 1983. Check-list of North American birds, 6th ed. American Ornithologist's Union, Washington, DC.
- Atwood, J.L. 1980. Breeding biology of the Santa Cruz Island Scrub Jay. pp. 675-688. In: The California Islands: proceedings of a multidisciplinary symposium (D.M. Power, ed.). Santa Barbara Natural History Museum, Santa Barbara, CA.
- Barbour, M.G. and J. Major. 1988. Terrestrial vegetation of California. Special publication of the California Native Plant Society: No. 9: pp. 893-906.
- Brown, P.E. 1980. Distribution of the bats of the California Channel Islands. pp. 751-758. In: The California Islands: proceedings of a multidisciplinary symposium (D.M. Power, ed.). Santa Barbara Museum of History, Santa Barbara, CA.
- Brumbaugh, R.W. 1980. Recent geomorphic and vegetal dynamics on Santa Cruz Island, California. pp. 139-158. In: The California Islands: proceedings of a multidisciplinary symposium (D.M. Power, ed.). Santa Barbara Museum of History, Santa Barbara, CA.
- Burton, J.A. 1973. Owls of the world, their evolution, structure and ecology. E.P. Dutton & Co. Ltd., London, U.K.
- Cannings, R.J. 1987. The breeding biology of Northern Saw-whet owls in southern British Columbia. pp. 193-198. In: Biology and conservation of northern forest owls: symposium proceedings (R. W. Nero, R. J. Clark, R. J. Knapton, R. H. Hamre, eds.). General Technical Report RM-142, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Cannings, R.J. 1993. Northern Saw-whet Owl (*Aegolius acadicus*). In: The Birds of North America, No. 42 (A. Poole and F. Gill, eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.
- Cody, M.L. 1966. A general theory of clutch size. *Evolution* 20:174-184.

- Collins, C.T. 1993. A threat display of the Northern Saw-whet Owl (*Aegolius acadicus*). *Journal Raptor Research* 27:113-116.
- Duffy, K. and P. Kerlinger. 1992. Autumn owl migration at Cape May Point, New Jersey. *Wilson Bulletin* 104:312-320.
- Dunning, J.B. Jr. 1993. *CRC Handbook of avian body masses*. CRC Press. Boca Raton, FL.
- Frost, B.J., P.J. Baldin and M. Csizy. 1989. Auditory localization in the Northern Saw-whet Owl. *Canadian Journal Zoology*. 67:1955-1959.
- Garcelon, D.K. and J.S. Romsos. 1994. Distribution and abundance of birds of prey on Santa Catalina Island. Unpublished report prepared for the Santa Catalina Island Conservancy.
- Garrett, K. and J. Dunn. 1981. *Birds of southern California: Status and Distribution*. Los Angeles Audubon Society, Los Angeles, CA.
- Godfrey, W.E. 1986. *Birds of Canada*. National Museums of Canada, Ottawa.
- Hamilton, R.A. and D.R. Willick. 1996. *The Birds of Orange County California: Status and Distribution*. Sea and Sage Press, Sea and Sage Audubon Society, Irvine, CA.
- Hobbs, E. 1980. Effects of grazing on the northern populations of *Pinus muricata* on Santa Cruz Island, California. pp. 159-166. In: *The California Islands: proceedings of a multidisciplinary symposium* (D.M. Powers, ed.). Santa Barbara Museum of History, Santa Barbara, CA.
- Hoffman, R. 1931. Saw-whet Owl and California Woodpecker on Santa Cruz Island. *Condor* 33:171.
- Holroyd, G.L. and J.G. Woods. 1975. Migration of the Saw-whet Owl in eastern North America. *Bird-Banding* 46:101-105.
- Johnsgard, P.A. 1988. *North American Owls: biology and natural history*. Smithsonian Institution Press, Washington, DC.
- Junak, S. 1995. *A flora of Santa Cruz Island*. Santa Barbara Botanic Garden, Santa Barbara, California and California Native Plant Society, Sacramento, CA.

- Minnich, R.A. 1980. Vegetation of Santa Cruz and Santa Catalina Islands. pp. 123-137. In: The California Islands: proceedings of a multidisciplinary symposium, (D.M. Powers, ed.). Santa Barbara Museum of History, Santa Barbara, CA.
- Mueller, H.C. and D.D. Berger. 1967. Observations on migrating Saw-whet Owls. *Bird-Banding* 38:120-125.
- Palmer, D.A. 1987. Annual, seasonal, and nightly variation in calling activity of Boreal and Northern Saw-whet Owls. pp. 162-168. In: Biology and conservation of northern forest owls: symposium proceedings (R. W. Nero, R. J. Clark, R. J. Knapton, R. H. Hamre, eds.). General Technical Report RM-142, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Peters, J.L. 1940. Check-list of birds of the world. Vol. 4. Harvard University Press, Cambridge, MA.
- Swengel, A.B. 1987. Detecting Northern Saw-whet Owls (*Aegolius acadicus*). *Passenger Pigeon* 49:121-126.
- Swengel, S.R. and A.B. Swengel. 1987. Study of a Northern Saw-whet Owl population in Sauk County, Wisconsin. pp. 199-208. In: Biology and conservation of northern forest owls: symposium proceedings (R. W. Nero, R. J. Clark, R. J. Knapton, R. H. Hamre, eds.). General Technical Report RM-142, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Taverner, P.A. and B.H. Swales. 1911. Notes on the migration of the Saw-whet Owl. *Auk* 3:329-334.
- Unitt, P. 1984. The Birds of San Diego County. San Diego Society of Natural History. San Diego, CA.
- Weir, R.D., F. Cooke, M.H. Edwards and R.B. Stewart. 1980. Fall migration of Saw-whet Owls at Prince Edward Point, Ontario. *Wilson Bulletin* 92:475-488.